Integration of Renewable Energy Sources in Germany

Opportunities and challenges

Dr. Aymen Chaouachi, Senior Power System Expert

elia grid international

Overview

Introduction

German RE penetration targets

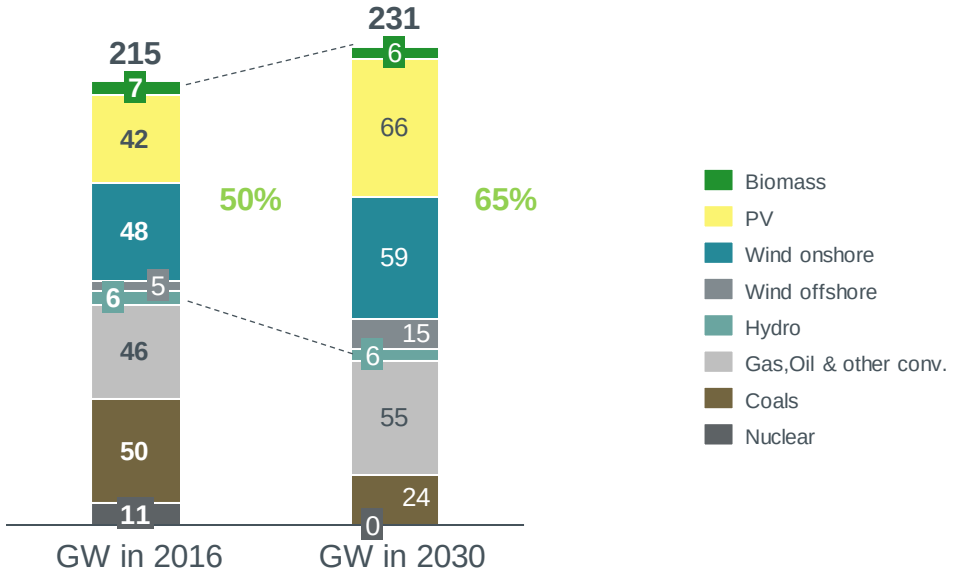
EU targets until 2020

-20%
Greenhouse gas emissions vs. 1990

20%
renewable energy share in gross final consumption

+20%
energy efficiency in primary energy

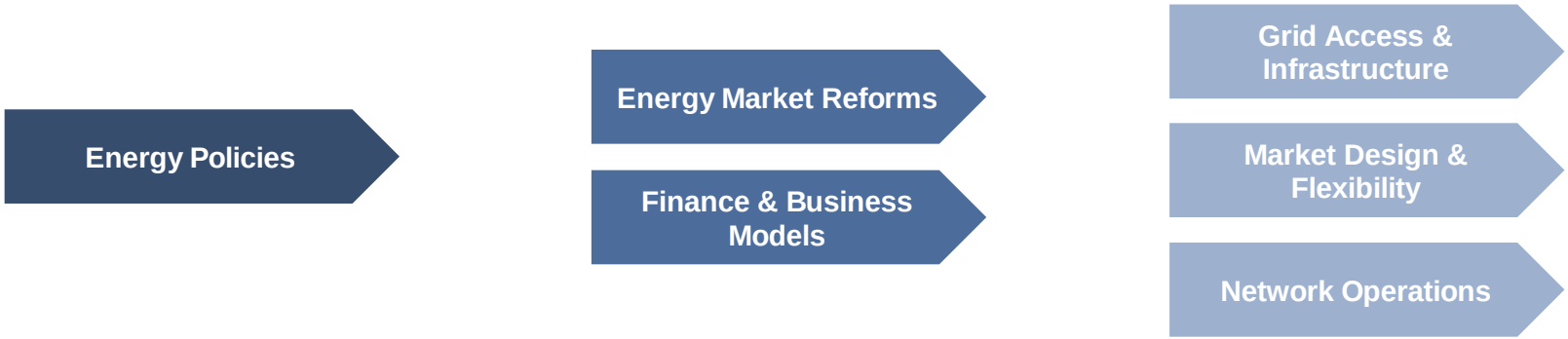
Flexible targets based on German potentials



- Targeted share for 2020 already reached today (50% RES delivered 35% in consumption)
- 65% of capacity in 2030 was set as new target (will equal to 52% in consumption)

The electricity sector must evolve to fully benefit from RES integration at an affordable cost

Framework encompassing electricity system paradigm



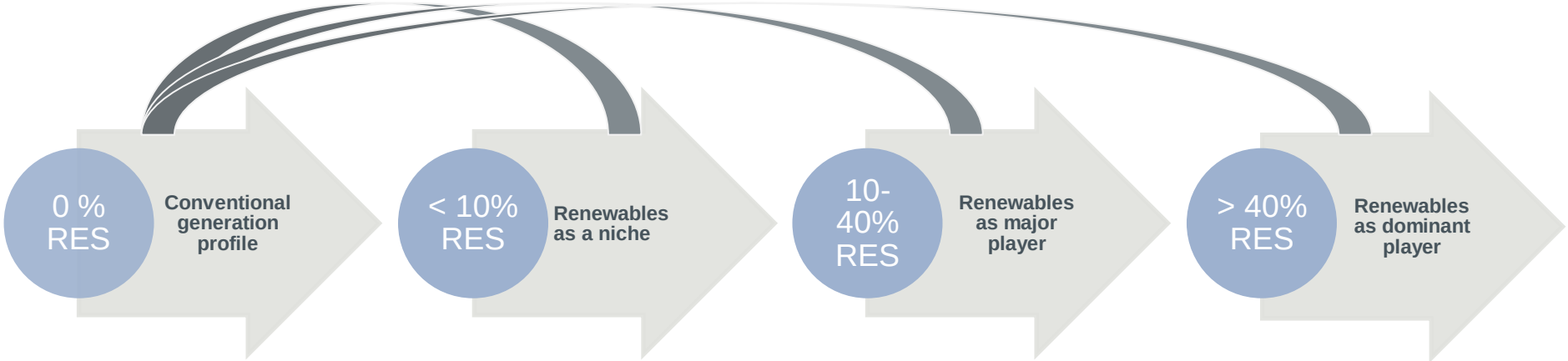
Strategic Targets
Policies ensure that long-term objectives are met

Structural Reforms
Reforms pave the way for RES implementation

System Transformation
System evolves with increasing RES penetration

Overview on RE generation integration challenges

System transformation: Major milestones



System operations : “Business as usual” PLUS be prepared for the future

Enhance generation management

Further develop and use forecasts

Develop processes for information exchange, billing and accounting for RES

System security is not yet affected

Forecasting instruments

Grid reinforcement

Real time data exchange and controllability of RES

RES contribution to ancillary services

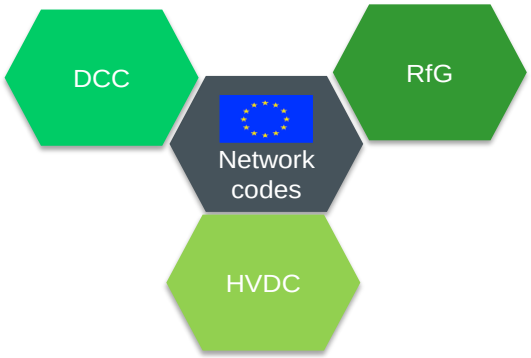
Full steering of conventional plants and RES

Substantially develop demand-side response

Real-time coordination between transmission and distribution

Paving the way toward system transformation

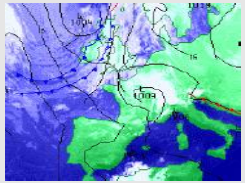
Harmonized state of the art grid codes

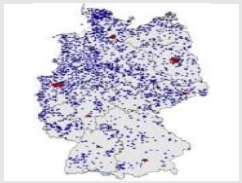


Grid Connection Related Codes

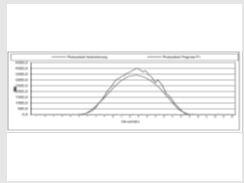
- Integration of new market players and leveraging flexibility
  - Demand units as significant Grid User
  - Level playing field for ancillary services:
    Voltage support
    Balancing and frequency support
- RES enhancing system not a burden
  - Controllability of active /reactive power to address congestions and participate in ancillary services
  - Maintain system robustness: FRT capabilities, fault-current support
  - Decentralized emergency and restoration functions (islanding, black start…)

50Hz PV generation forecasting


Wheather observation


SMA Database


Conversion to power

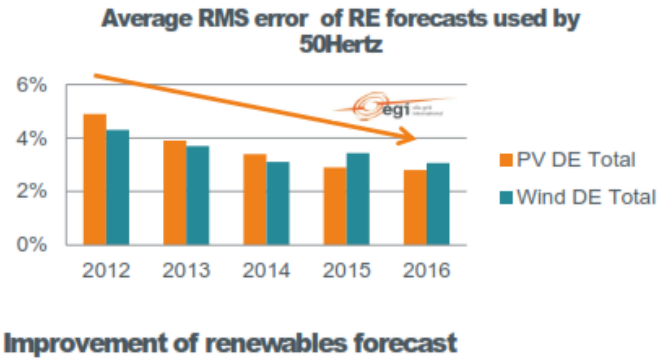

PV feed-in forecast

External input of meta-forecast:

- Solar power forecast 5 suppliers (EnergyMeteoSystems, Meteocontrol, Enercast, EnergyWeather, Meteologica) (in operation)
- Areas: Germany, 50Hertz, DSO regions and substations
- Horizon day-ahead <= 96 hours; horizon short term <= 8 hours
- 3 daily updates; ¼ hour short-term updates

Combined Forecast with weighted experience by 50Hertz

- Linear combination of commercially available forecasts and internal data from extrapolation

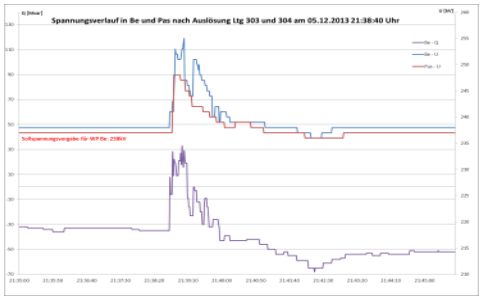


Improvement of renewables forecast

Accuracy of D-1 solar forecast has reached 1-2% Root Mean Square Error (RMSE), excluding night hours per week

Innovative approaches towards system and market integration of renewables

Example voltage control



- Storm „Xaver“2013/12
- After a loss of one two system line, wind park brings voltage back to the initial level

Example flexibility

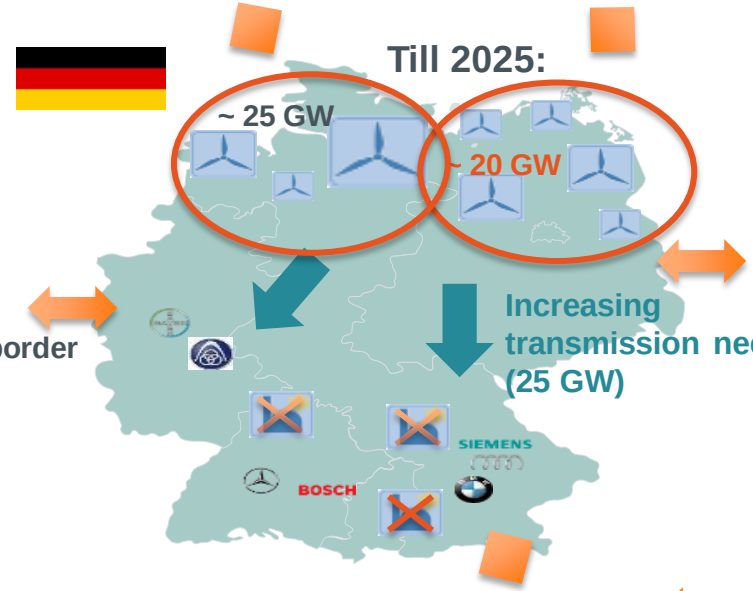
- 5 batteries in the area of 50Hertz provide frequency control
- E-mobility as peak shaving solutions possible in the future
- Industrial client providing frequency control

Example negative control power

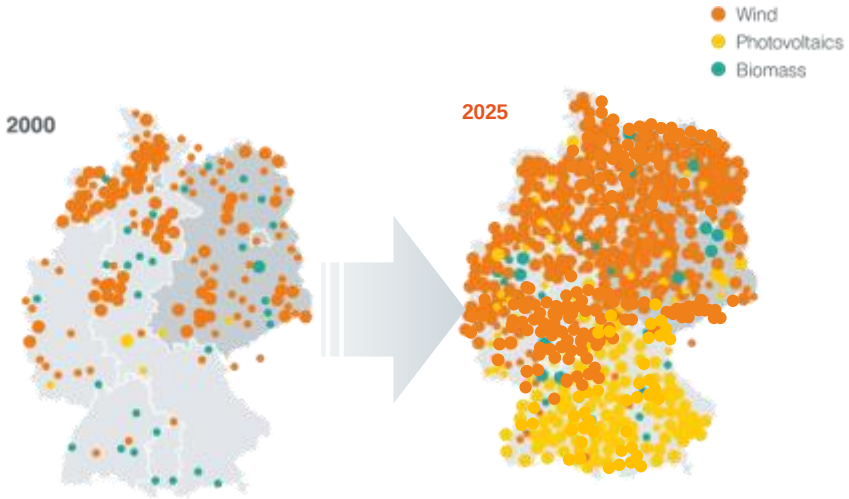
- February 2016: Prequalification of two wind farms (60 MW) for tertiary reserve by 50Hertz
- RE generation have already good downward regulation potential

RES and grid development the in Germany

Bulk transmission level



Decentralized level

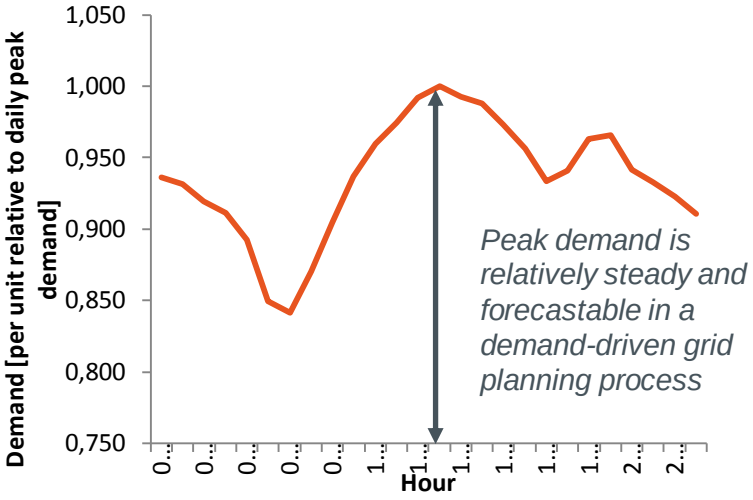


Development of 3 North-South HVDC corridors
Reinforcing backbone transmission network
Reinforcing cross-border interconnections

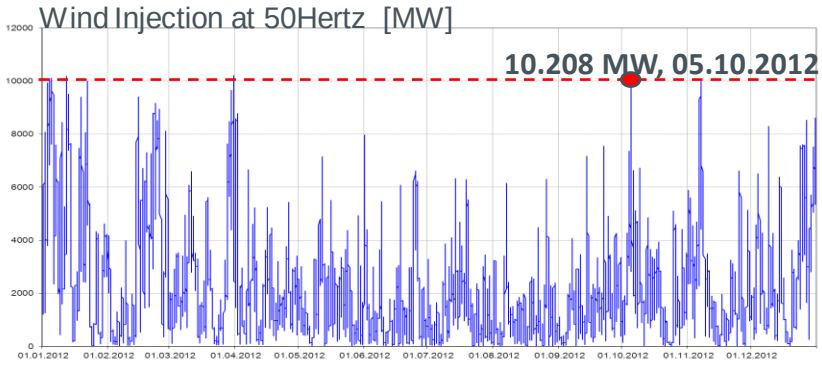
Massive DG RES (currently more than 1.6M units)
Reinforcement at distribution level

On Network planning practices and methodologies

Illustrative load pattern



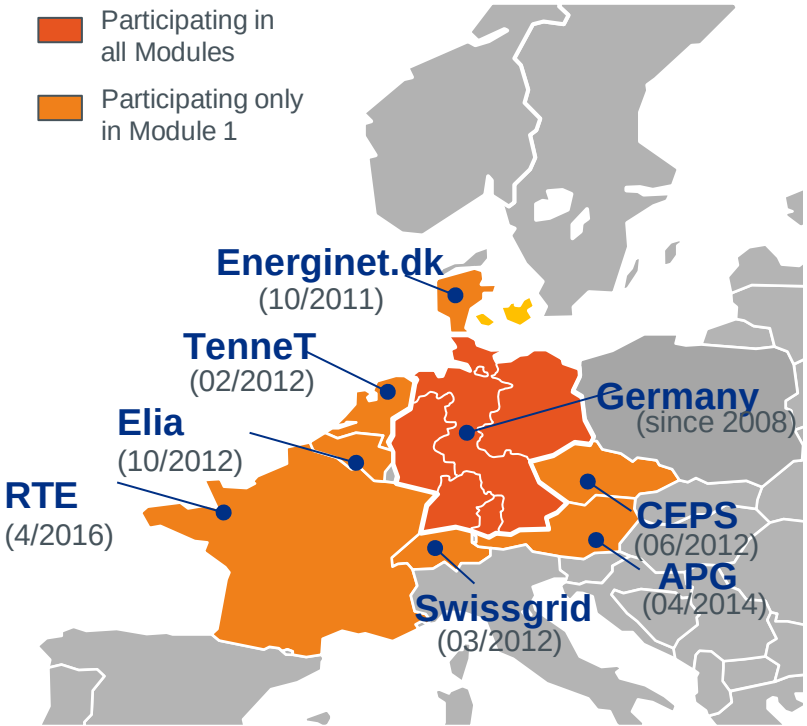
Quickly changing RES conditions – illustration from the German system



The traditional peak/off-peak methodology fits a demand-driven grid planning

RES volatility requires an extended grid assessment using multistate/probabilistic approaches

Toward full market integration and coordination



Grid control cooperation – functioning in four modules

- **Module 1:** Avoid activation of secondary control power in the opposite direction
  → reduction of secondary control energy
- **Module 2:** Joint dimensioning and mutual support with secondary control power among participating TSOs
  → reduction of secondary control power
- **Module 3:** Joint activation procedures: Activation signal will be provided by that TSO where the generator is connected
  → one common market area
- **Module 4:** Common Merit Order List or common control energy prices
  → further cost optimization

GCC – IGCC – full harmonized German market cooperation of TSOs to avoid activation of aFRR

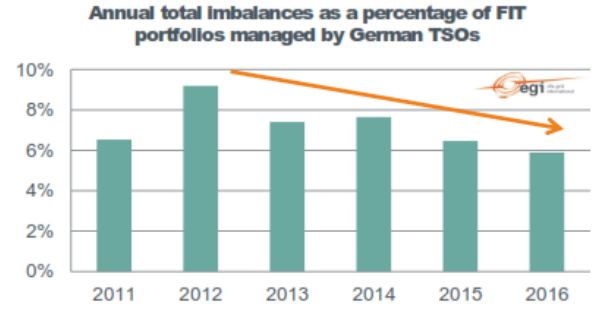
So far RE has been a driver for improvement !

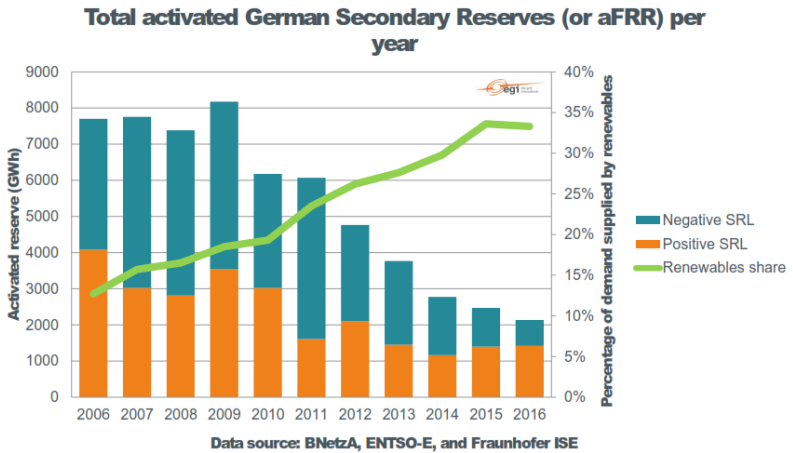
Enhancing RE generation forecasting

Enhancing system controllability and observability

Enhancing system flexibility and grid development

GCC – full harmonized German market
IGCC – cooperation of TSOs





Thank you for your attention

Elia Grid International

Rue Joseph Stevens 7 Joseph Stevensstraat
1000 Brussels – Belgium
Tel. +32 2 204 38 11
Fax +32 2 204 38 10

Eichenstraße 3A
12435 Berlin – Germany
Tel. +49 30 5150 37 11
Fax +49 30 5150 37 10

www.eliagrid-int.com

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